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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the quadrature type demodulator circuit of an FM receiver, and its adjusting device.
It is related with what was improved so that automation of adjustment of a quadrature type demodulator circuit could be attained especially.

[0002]
[Description of the Prior Art]The quadrature type demodulator circuit of an FM receiver takes out the demodulated result by carrying out the multiplication of the signal with which about 90 degrees of phases shifted from the input signal and this to which it should restore, With easy composition, while FM recovery is possible, only the recovery of a narrow-band (10 kHz thru/or about 20 kHz) can be performed. Therefore, it is used for the use of restoring to a 455-kHz FM wave chiefly, for example like the demodulator in mobile communication apparatus, such as automobile radio.
[0003]Drawing 2 is a block diagram of such a conventional quadrature demodulator circuit. They are a multiplier with which 1 carries out the multiplication of the two inputs in analog in a figure, and a phase converter with which predetermined carries out the angle part phase shift of 2, and it outputs the phase of one input signal of the multiplier 1 to the input of another side of the multiplier 1, The capacitor 21 connected in parallel with mutual, respectively, the resistance 22, the variable inductor 23, and the capacitor 30 connected among this three common node of the non-input side of the circuit elements 21, 22, and 23 and ground are comprised. And the capacitor by which 21 have the capacity of 330 pF among these circuit elements 21-23, and 30, the resistance whose 22 has the resistance of for example, 10komega, and 23 are variable inductors with the value of 330 microhenries. 30 is a bypass capacitor which has the capacity of 0.01-0.1 micro F. 7 is a coupling capacitor which removes the dc component of a wave to be got over and is inputted into the phase converter 2, for example, has the capacity of 10 pF. 3 is a low pass filter which passes the low-pass ingredient of the output of this multiplier 1, for example, has a 50-kHz cut off frequency. 6 is a capacitor for a direct-current cut which is inserted between the multiplier 1 and the low pass filter 3, removes the output dc component of the multiplier 1, and is inputted into the low pass filter 3, for example,

has the capacity of 0.1 micro F.

[0004]Next, operation is explained. A wave to be got over is inputted into the multiplier 1 and the phase converter 2. The phase converter 2 is the resonator which comprised the capacitor 21, the resistance 22, and the variable inductor 23.

By adjusting a variable inductor, 90 degrees of phases of input and output shift on the frequency of the subcarrier of a modulated wave, and it is set up so that a phase may change linearly before and behind carrier frequency.

Furthermore, the output of the phase converter 2 is inputted into the input of another side of the multiplier 1, and, therefore, the wave to which about 90 degrees of phases shifted from the modulated wave and the modulated wave is inputted into the multiplier 1. The multiplication of the two above-mentioned waves is carried out by a multiplier, and it is inputted into the low pass filter 3, and the low pass filter 3 removes the high-frequency component under output of the multiplier 1, and outputs a recovery wave. Although the frequency from which 90 degrees of phases of input and output shift in the above-mentioned phase converter 2 theoretically must be frequency equal to the resonance point of the parallel resonance machine which comprises the capacitor 21, the resistance 22, and the variable inductor 23, Actually, maneuver a point with impossible as a matter of fact making it correctly in agreement, and a parallel resonance point, and also adjusting correctly the carrier frequency of a modulated wave, and the parallel resonance frequency of the above-mentioned phase converter 2 Since it is actually impossible, the maximum points of a recovery wave output level, or a recovery wave -- a variable inductor is adjusted for a distorted minimum point etc. as substitution of the resonance point.

[0005]

[Problem(s) to be Solved by the Invention]Since the quadrature type demodulator circuit of the conventional FM walkie-talkie is constituted as mentioned above, The variable inductor had to be manually adjusted for adjustment of a phase converter, in the manufacturing process, the adjusting process was needed for the excess and there were problems, like this is connected with the cost hike of a device, and skill is required for adjustment and it is.

[0006]This invention was made in order to cancel the problem of the above conventional things, and an object of an invention is to obtain the quadrature type demodulator circuit of FM walkie-talkie which can adjust a phase converter automatically, and its equalization circuit.

[0007]

[Means for Solving the Problem]A quadrature type demodulator circuit of FM walkie-talkie concerning this invention, In the quadrature type demodulator circuit, a variable inductor which is one of the components of a phase converter, It constitutes from a voltage-controlled variable reactive element controlled by fixed-inductance element and a digital analog converter, and is made to output digital-control data for phase converter adjustment from a digital control circuit to this digital analog converter.

[0008]An adjusting device of a quadrature type demodulator circuit of FM walkie-talkie concerning this invention, A volts alternating current meter which measures an output of a multiplier, and a control circuit for adjustment which detects digital-control data in which digital-control data for phase converter adjustment is suitably outputted to a digital control circuit of a quadrature type demodulator circuit, and an output of the

above-mentioned volts alternating current meter becomes the maximum are provided.

[0009]

[Function]The phase converter of the quadrature type demodulator circuit of FM walkie-talkie in this invention, As mentioned above, since a circuit is constituted by the voltage-controlled variable reactive element by which a part for the reactance is controlled by the fixed inductance and a digital analog converter, the thing of composition of having been suitable for automation of adjustment of a phase converter can be obtained.

[0010]Since the equalization circuit of the quadrature type demodulator circuit of FM walkie-talkie in this invention detects automatically digital-control data for adjustment which measures the output of the multiplier of a phase converter in exchange, and makes this the maximum, it becomes automatable [adjustment of a phase converter].

[0011]

[Example]Below example 1. describes one example of this invention about a figure. Drawing 1 shows the quadrature type demodulator circuit of FM walkie-talkie by one example of this invention. They are a multiplier with which 1 carries out the multiplication of the two inputs in analog in a figure, and a phase converter with which predetermined carries out the angle part phase shift of 2, and it outputs the phase of one input signal of the multiplier 1 to the input of another side of the multiplier 1, The capacitor 30 connected with the common node of the capacitor 21 connected in parallel with mutual, respectively, the resistance 22, the fixed inductor 24, and the non-input side of these circuit elements 21, 22, and 24 between grounds, The voltage-controlled variable capacitor 25 mutually connected in series between the ground and the common node of the input side of the circuit elements 21, 22, and 24, and the fixed capacitor 29, The memory 28 which memorizes the information equivalent to the analog voltage value which should be impressed to the voltage-controlled variable capacitor 25, CPU27 as a digital control circuit which outputs the digital control voltage for phase converter adjustment by reading the information on this memory 28, The resistance 20 connected between D/A converter 26 which changes into an analog voltage signal the information read from the memory 28 by this CPU27, the common node of the voltage-controlled variable capacitor 25 and the fixed capacitor 29, and the output of D/A converter 26 is comprised.

[0012]The capacitor by which 21 has the capacity of 330 pF, and 22 For example, the resistance which has the resistance of 10komega, The fixed inductor in which 24 has a value of 330 microhenries, and 30 For example, the bypass capacitor which has the capacity of 0.01-0.1 micro F, The voltage-controlled variable capacity capacitor in which 25 has the capacity of 10-50 pF, the capacitor in which 29 has the capacity of 220 pF, and 20 are resistance with the value of for example, 100komega. 7 is a coupling capacitor which removes the dc component of a wave to be got over and is inputted into the phase converter 2, for example, has the capacity of 10 pF. 3 is a low pass filter which passes the low-pass ingredient of the output of the multiplier 1, for example, has a 50-kHz cut off frequency. 6 is a capacitor for a direct-current cut which is inserted between the multiplier 1 and the low pass filter 3, removes the output dc component of the multiplier 1, and is inputted into the low pass filter 3, for example, has the capacity of 0.1 micro F.

[0013]Although the phase converter of this example is constituted as mentioned above and the circuit was constituted from the conventional phase converter shown in drawing 2 by the capacitor 21, the resistance 22,

and the variable inductor 23 as mentioned above, It replaces with the variable inductor 23 and the fixed inductor 24 is used, the voltage-controlled variable capacity capacitor 25, D/A converter 26, CPU27, and the memory 28 are further added to this, and the circuit comprises this example.

[0014]Next, operation of this example is explained. First, the data in the state where adjustment was completed shall be written in the memory 28 by the adjusting device mentioned later. CPU27 reads periodically the same data written in the predetermined address of this memory 28, and outputs this to D/A converter 26. D/A converter 26 changes into analog direct current voltage this data read periodically, and impresses it to the voltage-controlled variable capacity capacitor 25 via the resistance 20. By this, the voltage-controlled variable capacity capacitor 25 will have the capacity according to this analog direct current voltage, and the phase converter 2 will carry out the phase shift of that input signal with the phase characteristic decided by this voltage-controlled variable capacity capacitor 25, the capacitor 21, the resistance 22, and the fixed capacity 24.

[0015]Therefore, the variable inductor which is one of the components of a phase converter according to this example, Since it was made to control by analog voltage which constituted by a fixed inductance and voltage control type variable reactance, and carried out D/A conversion of the this voltage control type variable reactance according to the data memorized by the memory, As a phase converter of the quadrature type demodulator circuit of FM walkie-talkie, the thing of composition of having been suitable for the automatic regulation can be obtained.

[0016]For this reason, by writing in the suitable data for the memory 28 with the adjusting device mentioned later, without it requires help work -- the maximum points of a recovery wave output level, or a recovery wave -- a distorted minimum point etc. can be measured, the resonance frequency of a phase converter can be adjusted automatically, and a phase converter can be adjusted automatically.

[0017]The adjusting device of the quadrature type demodulator circuit of FM walkie-talkie by the 2nd example of this invention which is a device which automates the adjustment is explained below to example 2. using drawing 3. In drawing 3, 1, 2, 21, 22, 24, 25, 26, 27, and 28 are the same as drawing 1. The AC voltage meter which measures the demodulation output to which 4 is outputted from the low pass filter 3, and 5 are the computers as a control circuit for an examination which measures automatically the measurement voltage of this AC voltage 4 [a total of], injects the data for phase converter adjustment into the memory 28 of the phase converter 2 based on this, and applies interruption to CPU27.

[0018]Here, the conditions of a device are set up as follows, for example. That is, D/A converter 26 shall change the output in 0-5V, and makes the resolution 8 bits. If interruption starts in 8 bits operation, CPU27 will read the value (the value A is called hereafter) of the predetermined address of the memory 28, and will output the value A to D/A converter 26. If the computer 5 can read AC voltage a total of four values here, and the value of the predetermined address of a memory can be rewritten and interruption can be applied, If the value A is shaken at 256 (=2^8) stages from 0 (=0V) to 255 (=5V) and AC voltage a total of four values are read, as for the value A from which a recovery wave output serves as the maximum, this can be found easily.

[0019]The flow chart figure in which drawing 5 shows operation of CPU27 of the phase converter 2 at the time of this inspection, and drawing 6 are the flow chart figures showing operation of the computer 5 which

performs the automatic meter reading of an AC voltage meter. In drawing 5, it is detected whether CPU27 of the phase converter 2 has required interruption from the computer 5 (Step 27a), If there is interruption, the contents of the predetermined address of the memory 28 will be read (Step 27b), and the value read from this memory 28 is outputted to D/A converter 26 (Step 27c).

[0020]The value outputted to this D/A converter 26 is changed into the analog voltage according to this, and is impressed to the voltage-controlled variable capacity capacitor 25, and this voltage-controlled variable capacity capacitor 25 presents the capacity value according to the output voltage of this D/A converter 26. The demodulation signal by which the phase shift was carried out with the phase converter 2 which has a phase characteristic decided by the value of the capacity value of this voltage-controlled variable capacity capacitor 25 and the capacitor 21, the resistance 22, and the fixed inductor 24, Multiplication is carried out with the multiplier 1 with a demodulation signal from the first, the multiplication result is inputted into AC voltage 4 [a total of] via the capacitor 6 and the low pass filter 3, the AC voltage is measured by this and the measured value is outputted to the computer 5 with a digital signal.

[0021]Here, in drawing 6, it writes this value in the predetermined address of the memory 28, the computer 5 setting to 0 the value A which should be written in the predetermined address of the memory 28 (Step 5a), and applying interruption to CPU27 (Step 5b). And the output of the demodulator outputted as mentioned above by this is measured by reading AC voltage a total of four values (Step 5c), and 1 is added to the value A (Step 5d). And it judges whether AC voltage a total of four values at this time are the maximum (Step 5e), and if this value is not the maximum, the above processing will be repeated until the greatest value is detectable (Step 5f). Thus, by detecting automatically the point that the output of this demodulator circuit serves as the maximum with AC voltage 4 [a total of], the resonance point of a phase converter can be adjusted automatically, the adjusting process which required help work can be automated, and FM walkie-talkie can be obtained cheaply.

[0022]The processing shown in above-mentioned drawing 6 is theoretic, and as long as the resonance point of a phase converter is automatically detectable, what kind of processing may be performed.

[0023]An amplitude measurement is performed by example 3. (i.e., 3-5 [suitable] out of changing voltage in 256 steps, as shown, for example in drawing 7) (5g of steps), Grasp the gross shape of a phase characteristic and two points including the peak from which the output of the demodulator of them serves as the maximum are detected (Step 5h), It is also possible by repeating this successively to perform more automatic detection of the resonance point of (Step 5k) and a phase converter at a high speed until it divides into two the section which makes the two points both ends (Step 5i), it detects whether a peak is included in which [the] side (Step 5j) and it can detect a peak.

[0024]Although the capacitor 21 and the voltage-controlled variable capacity capacitor 25 were separately formed in example 4. and the above-mentioned example, it may be made to include the capacity of this capacitor 21 in a voltage-controlled variable capacity capacitor.

[0025]Drawing 4 is a circuit diagram of the 4th example of this invention constituted in this way.

The point of difference with the circuit of drawing 1 is a point that there is no above-mentioned capacitor in drawing 4 to the capacitor 21 existing in drawing 1.

Thus, it is also possible to include the capacity of the capacitor 21 in the voltage-controlled variable capacity

capacitor 25, and, thereby, it is effective in the ability to constitute a device easily a little. It cannot be overemphasized that the circuit of this drawing 4 can also be adjusted in the equalization circuit of drawing 3.

[0026]

[Effect of the Invention]As mentioned above, according to the quadrature type demodulator circuit of FM walkie-talkie concerning this invention. The voltage-controlled variable reactive element from which the amount of reactance changes to the inside of a phase converter according to analog control voltage is provided, Since the digital-control data for phase converter adjustment outputted by the digital control circuit in this is changed into analog voltage and the capacity value was controlled, it is effective in the composition which was suitable for the automatic regulation by the addition of the easy circuit being obtained.

[0027]According to the adjusting device of the quadrature type demodulator circuit of FM walkie-talkie concerning this invention. Since digital-control data in which measures the output of a multiplier with a volts alternating current plan, the digital-control data for phase converter adjustment is outputted to the digital control circuit of a quadrature type demodulator circuit, and the output of the above-mentioned volts alternating current meter becomes the maximum was detected automatically, It becomes automatable [adjustment of a phase converter] and is effective in the ability to provide FM walkie-talkie cheaply.

[Translation done.]